

RFID comes of age



**A report from the Economist Intelligence Unit
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About the research

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The author of the report was David Jacoby and the editor was Gareth Lofthouse. The findings are based on extensive desk research and a programme of interviews with a range of experts and corporate practitioners in the field of radio frequency identification (RFID).

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Executive summary

Like many “hot” technologies, radio frequency identification (RFID) technology has its supporters and opponents. The technology enthusiasts believe RFID will unlock a multitude of valuable applications, ranging from mundane but highly economical track-and-trace technologies in the supply chain, to cutting-edge uses in the healthcare, military and security sectors. On the other side of the debate, consumer privacy groups have campaigned strongly against a technology that could, they argue, allow unscrupulous companies to gather and misuse sensitive information about their customers.

In reality, RFID is neither as powerful nor as dangerous as it is sometimes depicted—at least, not yet. What is already clear is that RFID can make many business transactions more convenient, improve product availability in stores, reduce fraud and theft, and help businesses run more efficiently. In short, it has the potential to make many things work a little bit better.

This briefing paper, which is based on interviews with a range of RFID providers, corporate users and experts, provides an overview of where RFID is likely to have the greatest impact over the next few years. It explores some of the problems companies face in exploiting RFID for commercial advantage, as well as the wider challenges faced by the RFID industry. The main conclusions of this report include the following:

- **RFID is gathering momentum.** The decision taken by leading global retailers to mandate use of RFID by their suppliers, aided by the emergence of global technical standards for RFID, have eliminated any doubt that the technology will be used on a broad scale. Pilot programmes in retail, consumer goods, logistics, life sciences, automotive and government sectors are under way and are already producing tangible benefits such as reduced costs, better inventory control and improved responsiveness to consumer demand.
- **The supply chain is becoming smarter.** RFID has already made its mark in the supply chain, with companies like Wal-Mart, Tesco and Gillette using it to track inventory and improve stock replenishment. Pilot RFID projects in these areas are already saving money and improving efficiency. But to fulfil its potential, RFID needs to become more than a glorified barcode. RFID, and the vast volumes of data that it generates, needs to be integrated into operational management tools such as ERP (enterprise resource planning) software. Used in this way, RFID could become a catalyst for much deeper collaboration between companies, and lead to the formation of “supplier networks” that will replace today’s linear supply chains.
- **RFID works for people as well as things.** RFID may fit naturally into the supply chain, but a range of other applications are emerging. One potential growth area for RFID is in applications that enhance consumer convenience: for example, “contactless payment” systems, which allow consumers to pay for goods without having physically to swipe a card, have already been proven to increase sales in some instances. Another growth area will be the use of RFID accurately to identify and authenticate people or items for safety or security purposes: for example, various governments have already incorporated RFID into passports, and healthcare professionals could soon be relying on smart tags to verify a patient’s identity and medical details at the operating table.
- **Much work remains to be done.** For all its promise, a range of technical, business and political barriers to RFID’s development still exists. Standards bodies and academic institutions need to harmonise hardware and software standards globally. For their part, companies and their solutions providers should lay out a framework that helps them understand and address the process changes required to get value from the technology. In addition to the technical issues, companies will need to assess RFID’s impact on



RFID to ROI: Seven steps to business value

1. Identify opportunities to differentiate products and services with radio frequency information before, during and after the sale by enhancing convenience, safety or security. Include contributors from marketing, supply chain, information technology (IT), and major trading partners.
2. Develop an integrated supply chain strategy that reduces out-of-stocks and improves cycle times through better identification and visibility of stocks. Perform a cost-benefit analysis versus barcodes and other tracking technologies such as GPS before investing in RFID as a supply chain solution.
3. Establish and post a privacy policy that integrates key concepts from existing voluntary guidelines such as EPCGlobal that are characteristic of today's "best practice". Consider how legislation driven by privacy advocacy groups may affect the commercial success and the image of your company, in light of your specific business and the potential RFID application.
4. Build a robust but flexible system of codes, readers, tags, middleware, and Internet access protocols that can grow with volume, advance in technological sophistication, and evolve with technical standards.
5. Standardise the set-up of the RFID solution—including internal processes, workflow, data capture, and packaging—to minimise interference and data loss, and maximise the effectiveness of the data to be captured via RFID.
6. Integrate RFID data and existing IT applications to unlock new opportunities, such as automatic invoicing, anticipatory stock replenishment and in-store customer recognition.
7. Stay ahead of advances in technology and standards globally by designating a RFID project manager and participating in industry forums that will shape the future of the technology.

workflow, marketing, sales and customer services.

● **Privacy can be protected without killing RFID.** The use of RFID in consumer goods has sparked controversy about consumer privacy. While some of the concerns raised overstate RFID's capabilities, there are genuine issues to be resolved. This report concludes that legislators should require that RFID tags be deactivated at point of sale to allay privacy concerns. But legislation should not require the permanent "killing" of stored data as this would limit users' ability to opt-in to interesting post-sale applications that benefit consumers as well as businesses.

The degree to which RFID will penetrate various industries will depend on the speed at which the cost of the tags and equipment declines, its cost relative to competing technologies, and the acceptable resolution of issues over privacy of data. Now the various players in the RFID industry have everything to gain by collaborating to ensure rapid, profitable growth with a minimum of controversy. Corporations, standards bodies, academic institutions, solutions providers, consultants and legislators need to put their weight behind resolving the remaining impediments to widespread adoption.



Tracking the rise of RFID

RFID had been hyped as a revolutionary new technology in recent years. But like the Internet, radio frequency identification has a long history stretching back to early applications in the military. The US and UK governments used an early form of RFID on airplanes in the second world war to determine if the plane was a friend or a foe. Retailers then began using the first Electronic Article Surveillance (EAS) tags to prevent shoplifting of clothing and other articles from their stores, a move that cut theft by 60%. In the 1970s, state and municipal governments began using automated toll collection devices powered by RFID, while keyless entry access cards and key rings using RFID devices become commonplace for buildings and vehicles in the 1980s. More recently, Mobil launched its Speedpass™ loyalty cards that allowed customers to refuel using contactless payment, putting RFID cards in the hands of 5m users and increasing sales by 3%.

RFID received a major boost when the Massachusetts Institute of Technology (MIT) set up the Auto-ID Center, along with charter members that included Coca-Cola, Gillette, Target, Home Depot and Wal-Mart. The Center worked to develop an item numbering scheme and to standardise the fragmented

hardware specifications through common frequencies, resulting in a new standard called the Electronic Product Code (EPC). This, combined with intense research into the hardware and software required to make RFID successful, helped to drive the cost of passive RFID tags down to about 10 US cents each. Recent technological improvements in tag design have greatly improved their practicality even further. So-called Gen2 tags (that is, second-generation tags) can be read with a high degree of consistency and accuracy, compared with failure rates of up to 30% when trying to read first-generation tags. This will make many more applications commercially viable.

Despite these steady improvements, the real breakthrough for RFID came in 2003 when Wal-Mart mandated that its top 100 suppliers label all incoming products with RFID tags that conformed to the MIT standards. Several other Auto-ID Center members followed suit with similar RFID mandates including Target, Best Buy, Albertsons and the US Department of Defense. The mandates put the technology to the test—which it nearly failed. Wal-Mart's suppliers initially resisted, not least because they were required to shoulder the cost of the "grand experiment", and because the technology proved more troublesome to implement than expected. Nevertheless, many other companies have since begun voluntary pilot

What is RFID?

Radio frequency identification (RFID) is a technology consisting of tags and readers that can exchange item-specific information wirelessly. Like bar codes, they are used to identify items (such as goods and materials, people or animals). Unlike

barcodes, RFID does not require direct contact or line-of-sight scanning. RFID tags can also store more data than a barcode.

An RFID system consists of a reader (combining an antenna and transceiver) and a transponder (the tag). The tag transmits data to the reader, usually triggering an action to occur. This could simply be an instruction to open an access gate, or a more complex process such as

interfacing with a database to carry out a financial transaction.

There are two types of RFID tags, each with different characteristics. "Passive" tags are paper-thin and can store small amounts of data that can be read from a few yards away when pinged. "Active" tags require a power source, can store more data, and transmit data farther. Active tags are larger than passive tags (think of a car's keyless entry fob).



programmes, which have helped to prove RFID's business value while enabling these organisations to work through some of the technology's teething problems.

"Gillette, P&G, Kimberly Clark, and Airbus have gone past questioning the technology and are leading the way," maintains Krish Mantripragada, director of RFID solutions strategy and business development for SAP. Gillette, which has run pilot programmes for Wal-Mart, claims a 20% reduction in warehousing and distribution costs from RFID. Wal-Mart says it has reduced stock shortages (known as out-of-stocks) by 16%. In Europe, Tesco and Marks & Spencer are also conducting pilot programmes with RFID tags. "Marks & Spencer improved its stock position by 60% during a pilot programme on mens' trousers," notes Ian Smith, CEO of AIM UK, a non-commercial trade association that represents the automatic identification and data capture industry based in Halifax in the UK.

Retail and consumer goods have led the way on RFID, but the logistics and transportation industries have also been active using RFID for inventory control, tracking and tracing. TNT Logistics uses RFID in its warehouses to ensure better management of laptops it ships from China to Germany. The Port of Long Beach uses active RFID tags to manage vehicles inside its yard gates. Delta, Las Vegas airport and Hong Kong airport use RFID to track baggage and to find lost baggage, and a Danish bus terminal is using active RFID to assign buses to gates, thereby alleviating congestion at the terminal.

More recently, the healthcare and life sciences industries have been experimenting with RFID for product authentication and tracking. A US pharmaceutical manufacturer, Purdue Pharmaceutical, has been "tagging every single bottle of oxycontin [a narcotic drug]. The laws force them to account for every bottle—where it was manufactured, where it's been stored, when it was shipped," says Mr Mantripragada of SAP. European legislation regarding

record-keeping is also making its use on blood samples more and more likely, according to Christine Ranger, head of safer practice for the National Patient Safety Agency in the UK.

Europe, Japan and South Korea are farther along in adoption of RFID than the United States, according to Mike Wills, vice-president and general manager of the Global Services Division of Intermec, a manufacturer of RFID and barcode readers. "Europe was an early adopter of many of the revolutionary methods for retail self-checkout and RFID item-level checkout. Tesco and other retailers pioneered it," says Mr Wills, adding that European consumers' early adoption of smart debit cards in the 1990s suggests that they may also become early users of RFID technology. Globally, the market for RFID solutions (inclusive of transponders, readers and software revenues) will have grown from \$1.4bn in 2003 to \$10.9bn by 2009, according to Allied Business Intelligence (ABI) Research, a New York based technology market research firm.

RFID in the supply chain...

With retailers and consumer goods manufacturers leading the way on RFID adoption, it is not surprising that most of today's applications are focused on the supply chain. However, in the long run greater opportunities may be found elsewhere. While supply chain management and inventory control will inevitably reach new degrees of sophistication, the benefits—such as reduced inventory levels and the removal of manual barcode scanning—are sometimes outweighed by the costs. Compared to barcodes, RFID can store information about the product, its history or its owner/customer; it can identify a product even if it is not in sight; and it can reduce scanning time and labour cost. However, RFID readers are much more expensive than scanners, and the tags cost a lot more than barcodes, which are nearly costless. "Barcodes



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have been refined to a science and work really well in a lot of cases,” explains Norm Ellis, vice-president of Qualcomm Wireless Business Solutions, a US wireless solution provider.

Higher costs have led many companies to restrict RFID tagging to particularly important items in the supply chain. An example would be the tagging of critical spare parts, where companies involved in activities such as aircraft maintenance can eliminate costly and error-prone record-keeping. RFID is also being used by the US military to track the march of munitions and supplies into battle, where the need for 100% inventory accuracy is paramount. For many items, however, barcodes will still be cheaper and building a business case for RFID may be more difficult. Phil Lazo, vice-president of RFID Infrastructure at Symbol Technologies, a manufacturer of readers, thinks that while supply chain applications will be the main focus of activity this year and next, RFID will expand into many other areas in the near future.

There is another view, however. Some experts argue that RFID could be a catalyst for much greater collaboration between companies along the supply chain. Stephen Miles, a research engineer at MIT’s Auto-ID Center, describes his vision of how RFID will change business processes: “We’re moving towards a world where operations are network-centric. There used to be vertical silos, [but in the future we’ll] have horizontal businesses that can integrate with each other.” These horizontal connections could enable a totally new cross-industry collaboration, believes Mr Miles. One practical example could be in collaborative sourcing where a retailer refers to a frying pan with one numbering system and a department store refers to the same frying pan with a different numbering system. The two have no idea that each is selling the same item, but if they shared consistent RFID data they could collaborate through the purchasing, development and promotion of the product. Mr Miles

argues that the flow of information will deepen partner collaboration, with companies ultimately forming supply networks and rendering obsolete the notion of a linear supply chain. Such theories are perfectly possible in the long term, and result from many broad trends in information technology, not just RFID.

If RFID is to revolutionise the supply chain, it will need to become much more than a glorified barcode. In order to accomplish this, companies will need to integrate RFID data flows into their standard business applications. This creates an opportunity for developers of integration software who “provide business context to the data”, according to Mr Mantripragada of SAP. Naji Najjar, sales and service leader for IBM’s Wireless Broadband and Sensing Unit Sensor & Actuator Solutions, believes what is needed is a “business integration tunnel” that filters out duplicate readings, consolidates data, and delivers it in a form that makes sense to billing, procurement and other applications. It is only when information can be aggregated and manipulated at the business level that RFID in the supply chain begins to become exciting in terms of its return on investment.

...and beyond the supply chain

Regardless of how the supply chain debate progresses, there are a number of other promising growth areas for RFID. The first of these are grouped around applications for consumer convenience. For example, successful pilot programmes have already been run using RFID-enabled smart tickets. Embedding passive chips in public transit passes and tickets to sporting events and concerts will become increasingly valuable as the chip in the ticket becomes smarter. Major sporting events and conferences from Shanghai to Kansas City have successfully embedded RFID chips in their tickets to



validate tickets and reduce entry queues.

Another consumer convenience application is contactless payment. RFID could allow debit card holders to pay remotely when in close proximity to the reader. MasterCard recently sold 5m of these cards through 7-Eleven stores in the US. Mobile phones with an RFID chip will have similar capabilities. And loyalty cards with an RFID chip will be able to be scanned from a distance.

As item-level tagging becomes more commonplace and applications emerge to integrate tag-reading and payment, far-flung concepts like checkout-free grocery stores and auto-replenishing cupboards will be seriously tested. Retail stores could use RFID scanning instead of cashiers and cash registers, and automatically bill their customers' credit cards as they walk out of the store without any wait. Grocery stores could even use RFID to replenish automatically their customers' cupboards or fridges based on the items that have been removed. Many of these applications should make life easier for consumers, although concerns over consumer privacy will have to be overcome for some of them to take off (see *Privacy versus convenience* below).

Another area where RFID looks set to flourish will be applications to validate the authenticity of people or things. For example, governments have been exploring RFID's use in border security. So far, Pakistan, Malaysia, Norway and New Zealand have issued passports with RFID chips embedded in them, and the US is evaluating a similar option. In the criminal justice systems, RFID can be used to track prisoners or offenders. The US state of Virginia has already issued an RFID-enabled driver's licence.

Accurate authentication is also important in the healthcare industry, where, for example, RFID can be used to safeguard against counterfeit drugs. Healthcare providers will be able to identify fake pills by tracking the chain of custody and by auditing their origin and history. Hospitals may also want to use RFID

as a safeguard when identifying patients. Ms Ranger of the National Patient Safety Agency (NPSA) in London recounts the case of a man who died in 2000 after surgeons mistook him for another patient and removed his only healthy kidney. The NPSA is exploring using RFID to ensure accurate patient identification, primarily through the use of wristbands, and the technology is being used in Birmingham, the UK for this purpose, although some experts say that interference with hospital equipment could make these kind of applications relatively difficult.

The other area where some promising applications for RFID are emerging is in product safety. For items with a high cost of failure, such as vehicle tyres, embedded RFID tags can help to manage maintenance intervals by transmitting telemetric data about the physical conditions via radio frequency. For example, the Chevrolet Corvette uses RFID chips embedded in the car's Michelin tyres to transmit tyre pressure to the driver in the cockpit.

Overcoming the obstacles

All this bodes well for RFID's future, but several obstacles remain, and one of the biggest is the need for global RFID standards. Until now, most of the standards work has been focused on the US market, and international agreement on how the next generation of RFID technologies should develop is by no means assured. The difficulty experienced in establishing global standards for mobile-phone technology suggests that this may be a protracted process.

Worldwide standards bodies such as EPCGlobal (the reincarnation of the MIT Auto-ID Center, which was officially dissolved in 2003), the European Telecommunications Standards Institute (ETSI) and the International Standards Organisation (ISO) need to collaborate closely to ensure consistency of their



hardware and software standards across regions. Some Europeans are not yet onboard with the EPC standard for passive tags; for example, Mr Smith of AIM UK thinks that the UK still needs to assess the best standards.

China may be pursuing another standard entirely. For example, a Chinese e-commerce company called SparkIce is developing a proprietary standard, according to some industry sources. Edward Zeng, its founder and CEO, and a member of the Chinese National Auto-ID Standards Working Group, says he is lobbying for China to have a greater say in the development of global RFID standards. He claims that EPCGlobal's members need to share more of their technology with Chinese firms, considering the size of the Chinese market and its importance in the supply chains of American and European CPG firms. He points out that the vast majority of mobile phones in China operate on a GSM standard because Nokia and Ericsson shared their technology more openly than their US-based competitors.

Even if the hardware technologies are standardised, software and coding still needs further research and harmonisation. "So far, most research has focused on the physical aspect of the technology," explains Intermec's Mr Wills. "Going forward, we'll need consumer goods companies (CPGs) and retailers' agreement on a particular set of data fields that include individual shipping information. We need to make it easier for the CPGs to adopt a uniform process inside their existing manufacturing lines. This will make it easier for the server and the data architecture people to make the information available to customers downstream and to serve operations and IT guys."

There will also be a growing need for RFID specialists with the technical expertise to design and support the array of applications outlined above. Several universities have already launched full-scale PhD programmes in RFID. In the meantime, corporate IT functions will need to assess the impact of IT on

their information data management strategy. Companies will need more systems experts to build an information data architecture that is more robust and network-centric. The sheer volume of information captured via RFID will require new storage and management technologies. "We'll need to learn to manage the terabytes of information that will be moving through this system," observes Mr Mantripragada of SAP.

Privacy versus convenience

RFID implementation in consumer goods and retail have generated a mountain of controversy about consumer privacy. Two US privacy groups, Caspian and EPIC, have staged rallies against RFID, and are pushing for a full review of the technology by the US Office of Technology Assessment (OTA) as a precondition to commercial use. A similar initiative is under way in Germany through the *stopRFID* campaign. Senator Joseph Simitian of California is fighting for passage of his "Identity Information Protection Act", which in an earlier version included language explicitly banning "contactless integrated circuits" in government-issued identification documents.

The privacy issue is "excessively hyped", in the words of Mr Smith of AIM UK, and won't slow or stop profitable RFID applications from moving forward. The technology is nowhere near being advanced enough to do the kinds of nefarious things that advocacy groups suggest, even if people were to try, and most objections are based on misunderstandings of the technology. Few people understand the difference between passive and active tags, so they either underestimate the cost of readers or overestimate the distance from which the tag can be read (roughly three to ten feet) as well as the ability of existing software and networks to process and share the information gathered through the system. Moreover, the data on passive tags pertain only to the product, and have,



according to Mr Lazo of Symbol, “no meaning unless you connect it to a database, and most people don’t have the database.”

Besides, as the technology’s supporters point out, many of the applications that concern privacy groups are already possible without RFID. Millions of people voluntarily carry loyalty cards, preferring to give up some information about themselves in exchange for price or service advantages.

On the other hand, several privacy issues are legitimate and must be addressed:

- Retailers could use readings from RFID-tagged items to conduct in-store marketing or promotions. By knowing where shoppers are in the store, their path through the store and how long they spent looking at certain products, they could beam customised adverts at them through screens on shopping carts. They could also charge discriminatory pricing based on anything they are wearing or carrying that is tagged (for example, customers wearing an expensive brand of clothing).
- Retailers could associate individual customer identities with items that they have bought, thereby allowing them to track individuals indefinitely after they make a purchase. While retailers would not track individuals once they are outside the store, they could identify shoppers each time they enter the store if they were wearing or carrying one of the company’s RFID-enabled products.
- Quite apart from retailers, anybody with an RFID reader could track people by the items they wear or carry. This could be particularly troublesome in the case of uniquely personal items—for example a tagged pair of shoes is usually worn by the same person. Celebrities and politicians could be tracked and monitored from the RFID tags in their clothes, and criminals could stalk victims in the same way.

So far, the industry has operated on the basis of voluntary privacy guidelines. EPCGlobal members must sign a privacy policy that obliges them to abide by the practices of: 1) consumer notice; 2) consumer choice (that is, the customer must be able to remove RFID tags); 3) consumer education; and 4) disclosure of companies’ policies regarding the use, retention and security of data collected via RFID. In response to major privacy concerns, Gen2 tags now have a built-in “kill” capability that allows their owners to erase them at point of sale.

Of course, voluntary guidelines are unlikely to protect consumers from rogue companies. Many organisations in the US and Europe are therefore seeking to enforce codes of conduct for RFID usage—but these ideas also have their drawbacks. Proposals in the US to suspend RFID’s use pending federal review would halt the adoption of even basic applications that raise no privacy concerns. Automatically killing data at point of sale would prevent the development of promising innovations such as automated grocery replenishment and RFID-based recycling (where tags are used to identify and sort different types of rubbish). Leaving the tags on but allowing consumers to remove them or otherwise “opt out” has also been proposed, but this would place a burden both on consumers—who would need to take the trouble to opt out—and on companies, which would need to establish acceptable opt-out procedures.

Chris Mirick, an attorney at a US law firm, Weil, Gotshal & Manges LLP, warns that legislatures that act before a technology matures may produce laws that are written so narrowly they don’t apply to what the technology is used for, or alternatively are so vague that they may be deemed unconstitutional. Tim Heffernan, director of government relations and public affairs at Symbol Technologies, also counsels against “legislating against technology and not legislating against bad behaviour”. But letting the market determine the outcome might place too much



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burden on the consumers whose privacy rights are genuinely infringed.

The best solution may be to require deactivation, but not necessarily killing, of the tags at point of sale.

This opt-in, rather than opt-out policy, would allay all but the most extreme consumer privacy concerns, and still allow consumers the option of signing up to reactivate the tags for specific post-sale benefits.

Two takes on RFID: Gillette and UPS

Gillette started trialling RFID at its distribution centre at Fort Devens, Massachusetts, in 2001. Since then it has cut some of its supply chain costs by 20%.

Gillette's experience demonstrates that significant savings can be achieved by making relatively minor improvements to basic logistical processes. For example, RFID has significantly improved the speed with which Gillette can process incoming supplies. Before RFID, this process required five scans and three keyboard entries to record the arrival of pallets into the distribution centre—a process that took 20 seconds per pallet, based largely on an operator needing to scan each case on the pallet. With RFID goods can be scanned while they are moving down a conveyor belt lined with readers, reducing the time required to scan each pallet to five seconds. The readings are 100% accurate.

Paul Fox, director of Global External Relations, says Gillette has begun to eliminate manual barcode scanning and redeploy labour to higher value-added activities. He envisions that RFID will also help to reduce stock-keeping discrepancies, shipment errors, and the amount of returned items as well as the time to process

them. Ultimately, Mr Fox thinks that RFID will help reduce or even eliminate the "bullwhip effect" in Gillette's supply chain—the creation of excess buffer inventory as a result of fluctuations in order volume.

Gillette is now expanding the RFID programme to more of its products. It restricted the initial RFID trials to its razor blades because they are expensive to stock and are frequently stolen from store shelves. However, it intends to use RFID for other products, including lower-value items, items that have high rates of inventory variance, product categories with high out-of-stock rates such as paper towels, and products with low brand loyalty such as oral care products, deodorants and anti-perspirants where consumers will defect to a competing brand if the product is not available on the store shelf.

It also predicts item-level tagging in the next five years. Item-level tagging will allow companies like Gillette to track goods once they are removed from a case or pallet, thereby increasing inventory accuracy. More importantly, however, Gillette also predicts item-level tagging in the next five to seven years. Item-level tagging will allow retailers and consumers to gain specific benefits from the technology, including reduced product theft, increased shelf replenishment, improved product recalls, increased product information, "checkoutless shopping" and automated recycling.

Not all companies have been won over by RFID, however. A US\$37bn company that delivers over 14m packages and documents per day might be expected to be keen to adopt RFID, but UPS is still looking for the business case.

A large part of the reason that UPS is not jumping on the RFID bandwagon is that the company made a major investment in its optical network for data capture (in effect, barcodes) in the 1980s, according to Bob Nonneman, manager of Industrial Engineering in charge of RFID. Many agree that UPS defined, or even invented, the science of barcode reading in high-volume situations by reducing process variation.

UPS implements RFID systems and solutions for its clients through its logistics subsidiary, UPS Supply Chain Solutions. However, it has no immediate plans to implement RFID in its small package network because the benefit over barcodes is not clear. "Technology won't bring ROI (return on investment) to the business. It's the business process that will drive the ROI. This is UPS's philosophy," says Mr Nonneman.

UPS's slow entry into RFID is indicative of the challenges that the technology will have to overcome to become ubiquitous in corporate supply chains. Companies will need to justify the RFID investment as an incremental benefit over their existing barcode schemes, which are fully amortised and operate at low variable cost.



Conclusions

RFID currently offers many benefits to a wide variety of industries. The consumer goods, retail, healthcare and defence industries have each contributed to the recent explosion of RFID applications. The transportation and automotive sectors have also made headway.

With the backing of major global brands, and increased convergence around global technical standards, RFID is gaining momentum. A wide range of potential applications is emerging, which could, for example, revolutionise the supply chain, change the way consumers shop, and improve security and safety practices in many industries. But a variety of parties, including businesses, standards bodies and legislators, need to co-operate to ensure that RFID fulfils its potential.

- **Standards bodies and academic institutions** need to extend the geographic agreement on the current standards, develop the full range of nomenclature and protocols to support active as well as passive tag systems, and train and educate IT experts in how to manage the massive amounts of data that will stem from RFID.

- **Businesses** should think beyond the supply chain and use RFID to differentiate their products and services in ways that tangibly benefit consumers. Some of the most promising applications are in consumer convenience applications, authentication, and service enhancement through the supply chain.

- **Solution providers and consultants** need to lay out a framework for implementation that addresses the process issues and helps companies choose and deploy the appropriate technology for their needs.

- **Legislators** should require RFID tags to be de-activated at point of sale, but stop short of requiring that the data be permanently killed.

RFID is ripe with potential applications, but it is not a panacea. "This is a marathon, not a sprint—it will take time," advises SAP's Mr Mantrigragada. There are many competing technologies, and RFID is still expensive compared to some of the alternatives. For the next few years industries and governments will adopt it where it has the greatest benefit and faces the least resistance. Like a wave that has gathered momentum, the path of RFID is predictable but obstacles are bound to cause interference along the way.

Whilst every effort has been taken to verify the accuracy of this information, neither The Economist Intelligence Unit Ltd. nor the sponsor of this report can accept any responsibility or liability for reliance by any person on this white paper or any of the information, opinions or conclusions set out in the white paper.

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